KODAK CUSTOMER SERVICE PAMPHLET 10¢

Solar-Eclipse Photography for the Amateur

AM-10

PROTECT YOUR EYES

Looking at the sun, either directly or through the viewfinder of your camera, can burn your eyes and cause blindness. Never look at the sun without adequate protection. Protecting your eyes adequately will reduce exposure to ultraviolet and infrared radiation, which can damage your eyes instantaneously without your immediately being aware of it. Also, adequate protection will increase eye comfort by reducing the intensity of the sun's visible rays.

VIEWING FILTER

Always use a filter that will absorb *equally* and *sufficiently* the ultraviolet, visible, and infrared energy of the sun. There have been some erroneous recommendations suggesting the use of materials that absorb the visible energy but do not absorb the dangerous, invisible infrared rays. One such suggestion involves the use of crossed-polarizing elements.

Medical authorities indicate that a neutral density filter of metallic silver, such as developed black-and-white photographic film, of at least 6.0 density will provide adequate protection, for VISUAL USE ONLY. Such filters are not suitable for photographic use. Place the filter IN FRONT OF your eyes before facing the sun. Such a filter can be made with two thicknesses of *black-and-white* photographic film, such as KODAK VERICHROME Pan Film, which has been completely exposed and developed to maximum density. You can completely expose the film by unrolling it and subjecting it to daylight. Develop the exposed film fully, according to the manufacturer's recommendations.

Do not use color film as a viewing filter.

FOCAL LENGTH OF THE LENS

The high light intensity of the sun permits you to use any camera. However, the size of the sun's image depends on the focal length of the camera lens. You can estimate the actual image size on the film by dividing the focal length by 110. For example, with a camera lens having a focal length of 4 inches (100mm), the image size would be about 4/110 inch (1mm) in diameter —the thickness of a dime. However, many good pictures of solar eclipses have been made with 35mm cameras equipped with lenses of 2-inch (50mm) focal length. So don't put your camera away because you don't have a long-focal-length lens.

In movies of the eclipse, the image will be enlarged when projected on the screen. Assuming a magnification of 110 diameters on

projection, the diameter of the image of the sun on the screen will be approximately equal to the focal length of your camera lens.

CAMERA PROTECTION

The sun can burn holes in focal-plane shutters, warp the leaves of between-the-lens shutters, and melt composition shutter blades. Use small lens openings and neutral density filters that are made *for photographic use.* If your camera must be pointed toward the sun throughout the eclipse, shade it between exposures.

AIMING YOUR CAMERA

NEVER look at the sun through a camera viewfinder without suitable filters. This is especially important with single-lens reflex cameras, both still and movie. The best policy is to "aim" your camera without using its viewfinder. If you must use the viewfinder, use filters (made from black-and-white film, as described on page 2) held *in front of the viewfinder or, with a single-lens reflex camera, in front of the camera lens.* The viewing filters are not safe to use in any other position on the camera.

Filters made for photographic use give NO VISUAL PROTECTION. Therefore, use the exposed-film filters for visual aiming and change to neutral density filters made for photographic use to take pictures of the eclipse. Once you have changed to filters for use on your camera, do not look through the viewfinder.

EXPOSURE

The light from the sun's surface is so intense that in order to photograph the partial phases of the eclipse, you must reduce the sun's light by 10,000 to 100,000 times. Neutral density filters (ND) provide the most convenient way of cutting down the light to allow normal camera exposures. (See "Filters" on page 8.) During the partial phases, the light intensity of the surface of the sun is the same as it is when there is no eclipse. Therefore, to determine the best exposure of the partial phases for your equipment, *make test pictures well in advance of the eclipse.* Here is a simple formula for determining the correct exposure for the partial phases:

$$f^2 = S \times t \times 10^{7-D}$$

where—

- f is the lens opening
- S is the "ASA" speed of the film
- t is the shutter speed in seconds
- D is the density of the neutral density filter in use

For example, with a neutral density filter of 5.0, KODACHROME-X Film (speed ASA 64), and a shutter speed of 1/125 second, you would use a lens opening of $f/8$; with a shutter speed of 1/60 second, you would use a lens opening of $f/11$.

Additional exposure information is given in the table on page 10. If

you are taking pictures with a simple nonadjustable camera, use KODAK VERICHROME Pan Film and a 5.0 ND (neutral density) filter during the partial phases. Remove the ND filter during totality.

If you have a camera with automatic exposure control, write to the manufacturer for information on how to use it to photograph the eclipse. If it's a Kodak camera, write to Eastman Kodak Company, Department 841, at the address given under "More Information" on the last page.

WHAT TO PHOTOGRAPH DURING A SOLAR ECLIPSE

Partial Phases

Beginning about 1 hour before totality, you can see the moon gradually encroaching on the sun's disk; for about 1 hour after totality, the shadow gradually retreats. You can obtain an interesting record of the eclipse by mounting your camera on a firm support and making a series of exposures at 5-minute intervals on the same frame of film, starting a half hour before totality and continuing for a half hour after. For this technique, you'll need to use a camera which will let you take more than one exposure on the same frame of film. Check your camera manual to see if you can do this with your camera.

The period over which you can make such a record on a single frame depends on the angle of view of your camera lens. The position of the sun will change about 15 degrees per hour. A normal-focal-length camera lens will cover a sufficient angle for exposures over a 2-hour period. Watch your local newspaper for the timing of the progress of the moon across the sun's disk; then plan your camera position and exposure schedule accordingly.

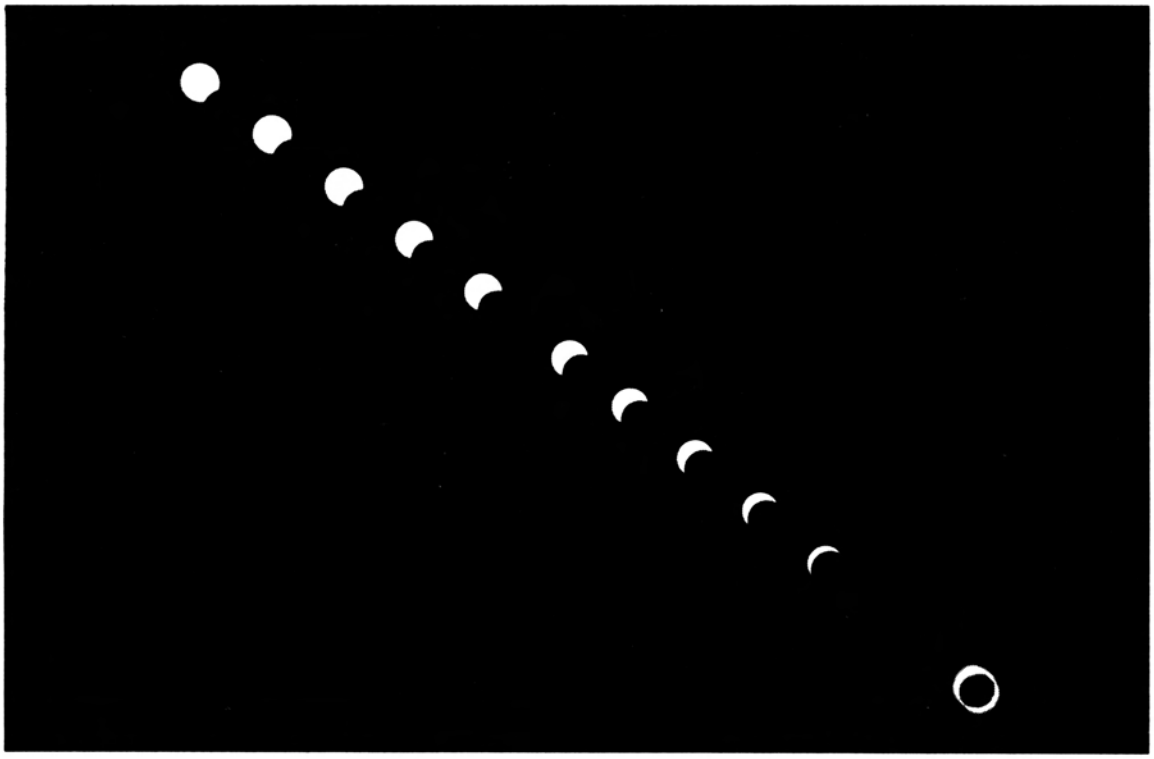
Shadows Under Trees

All during the partial phases, the sunlight filtering through the leaves of trees forms "pinhole camera" images of the eclipsed sun on the ground. You can photograph these crescents easily with normal exposures for the film you're using.

Shadow Bands

During the last few seconds before totality, you can usually see wavelike shadows, called shadow bands, moving over the ground. They average from 1 to 2 inches in width and are 5 or 6 inches apart. They are most easily visible on a white background, such as a bed sheet.

This phenomenon is very difficult to photograph because of the low illumination and the speed of movement. With a white sheet on the ground to obtain as high a reflectance as possible, you can expose KODAK TRI-X Pan Film in rolls or KODAK ROYAL Pan Film 4141 (ESTAR Thick Base) in sheets at 1/125 second with a lens opening of $f/2$. If the largest lens opening on your camera is $f/3.5$, you can use KODAK 2475 Recording Film (ESTAR-AH Base) or KODAK ROYAL-X PAN Film to record the shadow bands.



Multiple exposures show the progress of the eclipse in this picture made with a normal-focal-length lens. The eclipse was photographed at 5-minute intervals except for a 10-minute delay between the last two exposures.

Landscape During Totality

The intensity of the available illumination varies rapidly during the minute just before, and the minute just after, totality. At the darkest period (during totality), an exposure of about 1/2 second at *f*/8 on KODAK VERICHROME Pan Film (speed ASA 125) should give good results for landscape photography.

During totality, you may not be able to see the settings on your camera. Carry a pocket flashlight so that you can check or change your camera settings.

The Eclipse Itself

Totality usually lasts less than 5 minutes. Therefore, plan well in advance and be prepared so that you can take several pictures during this brief period.

Baily's Beads

For a second or two, just before totality and again just as the sun emerges, light breaks through the valleys on the rim of the moon, forming what looks like a beaded necklace along the edge of the moon. This is very spectacular and very short-lived.

For still cameras, use a shutter speed of 1/15 second, and the same lens opening and ND filter recommended for partial phases in the exposure table on page 10. For movie cameras that have manually

adjustable lens openings, open the lens three stops; for example, if the table indicates *f*/11, use *f*/4.

Corona

At totality, the corona appears around the sun as a beautiful halo, decreasing in brightness from the moon's rim outward. Points of interest to observe and photograph in the outer corona are the equatorial streamers, which may extend several diameters from the sun. In the inner corona, the chief point of interest is the phenomenon of solar prominences. These prominences are scarlet, tongue-like jets shooting outward from behind the moon's rim.

Since the intensity of the corona fades rapidly away from the solar limb (edge of the sun's apparent disk), the distance to which the photograph will show the corona depends on the exposure—the longer the exposure, the greater the extension. However, if you attempt to record the faint outer streamers, then the inner white corona will be overexposed. For most purposes, the most spectacular results are usually obtained with the shorter exposure, gauged to record the inner corona.

EQUIPMENT

Using Small Telescopes and Binoculars

You can use a small telescope or binoculars in conjunction with an ordinary camera. The image size obtained with such a combination will be equal to that obtained with your camera alone multiplied by the power of the telescope or binoculars. It is best to build some type of rigid support to hold your telescope and camera in alignment.

You can arrive at the best focus and exposure for the partial phases experimentally by photographing the sun prior to the eclipse. Make an approximate focus setting by focusing the telescope or binoculars on an object at a great distance. Then set your camera lens at infinity, and at the largest lens opening to avoid possible vignetting of the image. Join the camera and telescope, covering the space between the camera lens and the eyepiece of the telescope with a black cloth to cut out stray light.

For determining exposure, you need to know the "effective *f*-number" of the combination. To calculate the effective *f*-number, first multiply the focal length of your camera lens in millimeters (mm) by the magnifying power of your binoculars. Then divide this answer by the diameter of the objective lens of your binoculars (in millimeters) to determine the effective *f*-number.

For example, assume you have a camera with a lens of 50 millimeters focal length, and a pair of 7 x 50 binoculars. The "7" is the magnifying power of the binoculars, and the "50" is the diameter of the objective lens, the front lens, expressed in millimeters. If the focal length of your camera lens is expressed in inches, multiply it by 25.4 to convert it to millimeters for use in the formula.

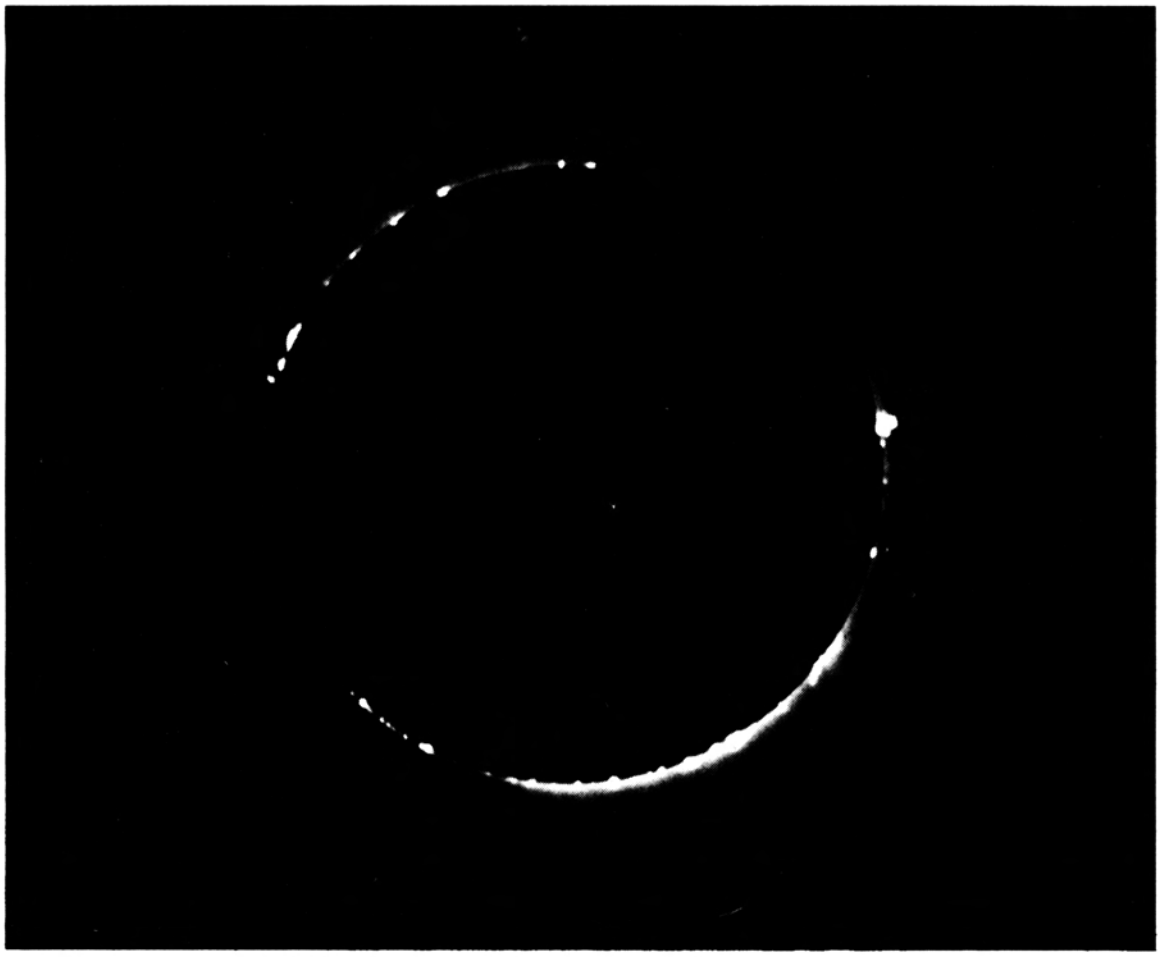
$$\frac{\text{Focal length of camera lens x Binocular power}}{\text{Diameter of binocular objective lens}} = f\text{-number}$$

$$\text{Example: } \frac{50 \times 7}{50} = 7$$

The effective *f*-number is *f*/8, for all practical purposes.

You can obtain more information on taking photographs through telescopes or binoculars by requesting the KODAK Customer Service Pamphlet *Astrophotography with Your Camera* (AC-20) or *Picture-Taking Through Binoculars* (AC-28) from your photo dealer or from Eastman Kodak Company; see "More Information" on the last page.

For spectacular close-up views such as this one, which shows the solar prominences, take the pictures through a telescope with your camera.



Camera Support

For a series of pictures of the partial phases, mount your camera on a tripod or some other rigid support to prevent movement between exposures. Also, with long-focal-length lenses, or when you use your camera with a telescope or binoculars, a solid support is essential to avoid loss of definition due to camera motion.

Because of the earth's rotation, solar images 1 inch in diameter or greater will show significant movement on the film during exposures of 1 second or more. For such exposures, an equatorial mounting with a clock drive may be desirable. (Refer to books on amateur astronomy or to *Astrophotography with Your Camera,* AC-20, mentioned earlier.) If your exposures exceed 1 second, and no drive mechanism is available, the diameter of the solar image should not exceed 1/2 inch for satisfactory detail resolution.

Filters

The use of neutral density filters is a convenient way of reducing the excessive light intensity for photography during the partial phases. You can quickly remove the filters from in front of the lens at totality. The viewing filters which were described on page 2 are not suitable for photographic use.

KODAK WRATTEN Neutral Density Filters, No. 96 (gelatin film), are available in the following densities: 0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 0.90, 1.00, 2.00, 3.00, and 4.00. You can obtain intermediate densities or higher densities, such as 4.50 or 5.00, by combining two of the standard filters and adding their densities. However, loss of definition will result if you use more than two at one time. These filters are available through photo dealers. If your dealer doesn't have them in stock, he can order them for you.

Neutral Density Filters

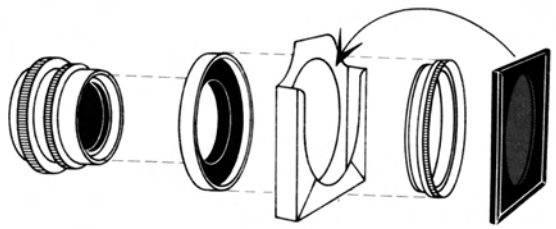
Neutral Density	Filter Factor	Reduces Exposure by (*f*-stops)
0.1	1 1/4	1/3
0.2	1 1/2	2/3
0.3	2	1
0.4	2 1/2	1 1/3
0.5	3	1 2/3
0.6	4	2
0.7	5	2 1/3
0.8	6	2 2/3
0.9	8	3
1.0	10	3 1/3
2.0	100	6 2/3
3.0	1,000	10
4.0	10,000	13 1/3
5.0	100,000	16 2/3
6.0	1,000,000	20

WARNING

Do not try to observe a solar eclipse through filters made for photographic use because they transmit infrared energy which can burn your eyes.

Although gelatin-film neutral density filters are protected by a thin lacquer coating, you should handle these filters only by the edges or at the extreme corners. The KODAK Gelatin Filter Frame, a two-part metal frame, is a convenient accessory for handling gelatin filters.

You can use the filter frame with the KODAK Gelatin Filter Frame Holder, which you attach to your camera lens with an appropriate adapter ring. The filter frame holder is convenient to use because you can change filters rapidly, but it's not a necessity. You can attach the filter frame, or even the filters alone, to the lens with small strips of pressure-sensitive tape.



The KODAK Gelatin Filter Frame Holder and a KODAK Gelatin Filter Frame provide a convenient means for attaching gelatin-film neutral density filters to your lens. *These filters are not for visual use.*

When you use neutral density filters, be sure you don't confuse their density values. For example, a .50 neutral density filter reduces the light by 3 times while a 5.00 neutral density filter reduces the light by 100,000 times!

Some neutral density filters are identified as 2X, 4X, 8X, and 10X. These designations indicate the filter factor and are equivalent to the following densities: 2X=.30, 4X=.60, 8X=.90, and 10X=1.00. The filter factor indicates how many times the filter reduces the light. For example, a filter factor of 4 means that the filter reduces the light by 4 times.

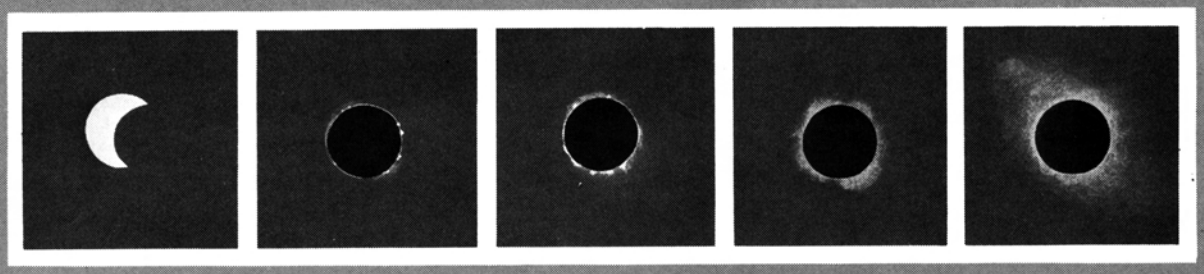
EXPOSURE TABLE

The exposures given in the table on the next page have been calculated from those which have given satisfactory results, based on information supplied by a number of scientists who have made satisfactory photographs of eclipses. So much depends on atmospheric conditions, however, that you should regard these exposures only as approximate guides.

Exposure for each phase of the eclipse can vary over a wide range and still produce good photographs. If you take several pictures at different exposure settings, each picture should show different details of the eclipse. This is especially rewarding during totality. Therefore, for the best coverage, bracket the suggested exposure. Take pictures at the estimated exposure and at 1, 2, and 3 stops less exposure and more exposure than the estimate.

You can calculate exposure times for lens openings other than those given in the table. Suppose the effective lens opening of your lens is $f/32$ and the table suggests $f/8$. Divide 32 by 8 and square the answer: $32 \div 8 = 4$ and $4^2 = 16$. Therefore a lens opening of $f/32$ will require an exposure 16 times as long as that required at $f/8$.

The exposure time for movie cameras operating at a normal camera speed of 16 or 18 frames per second is about 1/35 second.



PARTIAL PHASE | BAILY'S BEADS | PROMINENCES | INNER CORONA | OUTER CORONA

SOLAR-ECLIPSE PHOTOGRAPHY FOR THE AMATEUR
Approximate Exposures for Still and Movie* Cameras

Speed (ASA)	Partial Phases		Totality (Prominences)		Totality (Inner Corona)		Totality (Outer Corona)	
	STILL	MOVIE	STILL	MOVIE	STILL	MOVIE	STILL	MOVIE
25-32	*f*/5.6 5.00 ND 1/125	*f*/11 5.00 ND	*f*/3.5 No Filter 1/125	*f*/8 No Filter	*f*/3.5 No Filter 1/15	*f*/2.8 No Filter	*f*/3.5 No Filter 1/2	*f*/1.4 No Filter
40-50	*f*/6.3 5.00 ND 1/125	*f*/13 5.00 ND	*f*/4.5 No Filter 1/125	*f*/9.5 No Filter	*f*/4.5 No Filter 1/15	*f*/3.5 No Filter	*f*/4.5 No Filter 1/2	*f*/1.9 No Filter
64-80	*f*/8 5.00 ND 1/125	*f*/16 5.00 ND	*f*/5.6 No Filter 1/125	*f*/11 No Filter	*f*/5.6 No Filter 1/15	*f*/4 No Filter	*f*/5.6 No Filter 1/2	*f*/2 No Filter
125-160	*f*/11 5.00 ND 1/125	*f*/22 5.00 ND	*f*/8 No Filter 1/125	*f*/16 No Filter	*f*/8 No Filter 1/15	*f*/5.6 No Filter	*f*/8 No Filter 1/2	*f*/2 No Filter
200-250	*f*/16 5.00 ND 1/125	*f*/9.5 6.00 ND	*f*/11 No Filter 1/125	*f*/22 No Filter	*f*/11 No Filter 1/15	*f*/8 No Filter	*f*/11 No Filter 1/2	*f*/2.8 No Filter
400-650	*f*/16 5.00 ND 1/250	*f*/11 6.00 ND	*f*/16 No Filter 1/125	*f*/11 1.00 ND	*f*/16 No Filter 1/15	*f*/9.5 No Filter	*f*/16 No Filter 1/2	*f*/4 No Filter
1000-1250	*f*/16 5.00 ND 1/500	*f*/16 6.00 ND	*f*/16 No Filter 1/250	*f*/16 1.00 ND	*f*/16 No Filter 1/30	*f*/13 No Filter	*f*/16 No Filter 1/4	*f*/5.6 No Filter

*The lens openings given for movie cameras are based on a normal camera speed of 16 or 18 frames per second.

Note: ND indicates "neutral density filter."

KODAK FILMS

For the partial phases, you can use any film intended for general photography. For the most interesting phases of an eclipse, those occurring during totality, a high-speed film is desirable. The following films are recommended for photographing the eclipse. You can use the "ASA" speeds with the exposure table on page 10 and with the formula on page 3.

KODAK Black-and-White Films—Rolls	**Speed (ASA)**
PANATOMIC-X (135, 120)	32
VERICHROME Pan (110, 126, rolls)	125
PLUS-X Pan (135)	125
PLUS-X Pan Professional (120, 220)	125
TRI-X Pan Professional (120, 220)	320
TRI-X Pan (126, 135, rolls)	400
2475 Recording (ESTAR-AH Base) (135)	1000
ROYAL-X Pan (120)	1250

KODAK Black-and-White Films—Sheets	
EKTAPAN 4162 (ESTAR Thick Base)	100
PLUS-X Pan Professional 4147 (ESTAR Thick Base)	125
SUPER-XX Pan 4142 (ESTAR Thick Base)	200
Super Panchro-Press 6146, Type B	250
TRI-X Pan Professional 4164 (ESTAR Thick Base)	320
ROYAL Pan 4141 (ESTAR Thick Base)	400
ROYAL-X Pan 4166 (ESTAR Thick Base)	1250

KODAK Color Films—Rolls	
KODACHROME II (Daylight) (135, 828)	25
KODACHROME-X (110, 126, 135)	64
EKTACHROME-X (110, 126, 135, rolls)	64
KODACOLOR-X (126, 135, rolls)	80
KODACOLOR II (110)	80
EKTACOLOR Professional, Type S (135, rolls)	100
High Speed EKTACHROME (Daylight) (126, 135, 120)	160

KODAK Color Films—Sheets	
EKTACHROME 6115, Daylight Type (Process E-3)	50
EKTACOLOR Professional 6101, Type S	100

KODAK Color Movie Films	Speed (ASA)
KODACHROME II Movie (Daylight) (8mm, 16mm)	25
KODACHROME II Movie (Type A) with No. 85 filter (super 8, 8mm, 16mm)	25
EKTACHROME 40 Movie (Type A) with No. 85 filter (super 8)	25
EKTACHROME 160 Movie (Type A)* with No. 85 filter (super 8)	100
EKTACHROME MS 7256 (16mm)	64
EKTACHROME MS 2256 (ESTAR Base) (16mm)	64

KODAK Black-and-White Movie Films	
PLUS-X Reversal 7276 with No. 85 filter (super 8)	32
PLUS-X Reversal 7276 (16mm)	50
TRI-X Reversal 7278* (super 8, 16mm)	200
4-X Reversal 7277 (16mm)	400

Note: The No. 85 filter is built into most super 8 cameras and some 8mm cameras. See your camera manual.

*If you have a super 8 camera, see your camera manual or write to the manufacturer to determine whether you can use these films in your camera. If it's a Kodak camera, write to the address given under "More Information."

MORE INFORMATION

If you have additional questions about photographing the solar eclipse, write to Eastman Kodak Company, Photo Information, Department 841, Rochester, New York 14650. If you would like a copy of *Astrophotography with Your Camera* (AC-20) or *Picture-Taking Through Binoculars* (AC-28), see your photo dealer or write to this same address.

A wide selection of KODAK Photo Information Books is usually stocked and sold by photo dealers. Be sure to get a copy of *KODAK Films for the Amateur* (AF-1), $1.25, *and the KODAK Master Photoguide* (AR-21), $2.50 —a handy reference tool for both outdoor and indoor photography.

Try your dealer first for the books you want; if he can't supply them, you can order by title and code number directly from Eastman Kodak Company, Department 454, Rochester, New York 14650. Please send your money order or check with the order including your state and local sales taxes. Prices are subject to change without notice.

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